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AUTHOR Tull, Delena
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by Delena Tull
Biology Dept., University of Central Arkansas
Conway, Arkansas 72035
(501) 450-5930

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Social Constructivism: Botanical Classification Schemes of Elementary School Children

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Abstract

The assertion that there is a social component to children's construction of knowledge about natural phenomena is supported by evidence from an examination of children's classification schemes for plants. An ethnographic study was conducted with nine sixth grade children in central Texas. The children classified plants in the outdoors, in a sorting task, in a slide identification task, and in a free listing task. Of the nine major plant categories used by the children, the labels for eight would be recognized by adults: plants, tree, bush, flowers, cactus, weeds, grass, vines. The children's classification scheme differed from that of botanists but strongly resembled that of adult laymen, demonstrating a socially constructed system of classification. Kempton (1981) calls this a folk classification scheme. Reliance on a prototype allows communication to occur between individuals despite idiosyncratic differences in meaning.

Social Constructivism: Botanical Classification Schemes of Elementary School Children

> When symbols function as categories, they serve to reduce the complexity of human experience.... Without symbolic categories for everything we experience, we could become hopelessly enslaved to the particular. One of the most important functions of every human language is to provide people with ready-made categories for creating order out of the complexity of experience (Spradley, 1979, p. 98).

An ethnographic study was conducted to determine the plant classification categories used by nine sixth grade children. Category membership and the criteria for including plants in the various categories were examined. The following questions were pursued: How is category membership determined? Do the categories resemble plant categories that would be recognized by botanists or by adult laymen? Are the language and meanings for plant categories idiosyncratic or is there evidence that they are socially constructed?

Rationale

Research in education has demonstrated that children come to school with a body of knowledge about the world around them. From the early studies of Piaget (1929) to the many studies of the past decade (see Carey, 1985; Helm & Novak, 1983; Osborne & Wittrock, 1983) researchers have examined children's explanations of natural phenomena.

Recent research indicates that students do not simply absorb knowledge, rather they "constantly interpret new information based on their particular world view" (Linn, 1987). Von Glasersfeld (1979) asserts that "cognition must be considered a process of subjective construction on the part of the experiencing organism rather than a discovery of ontological reality."

Osborne and Wittrock (1983) stated that learning science often requires "the restructuring of existing ideas so that pupils view things from a different model, rather than adding the new information to existing knowledge." New information introduced during the school years must, therefore, take into account the conceptual framework of the child.

While the child's explanation of natural phenomena appears naive from the scientific viewpoint, we must not overlook the possibility that the child's explanation may be consistent with the viewpoint of the adult layperson. Hills (1983) has suggested that the child's interpretation differs from that of the scientist because the child is working within a different theoretical framework, what Hills calls the "commonsense framework" (p. 268).

Commonsense meanings are frequently what anthropologists would call folk meanings, meanings based on social constructions. Kempton (1981) explained that "Folk systems are used by the common people, have multiple authors... are transmitted informally from generation to generation, and change through time." In contrast, devised classification systems, such as the taxonomic systems used by botanists, are created by and follow conventions decided upon by a group of scientists.

For the child, folk language and meanings have relevance on a daily basis. The language and meanings of the scientist may have relevance only for the few minutes each week that the child engages in the study of science in the classroom. Kempton pointed out that folk terms, rather than scientific terms, comprise the majority of terms used in a language.

Concepts may have concrete referents (e.g., car, dog) or they may represent abstract ideas (e.g., God, love). Regardless of whether the referent is concrete or abstract, a concept itself is a generalization and therefore an abstraction. In this study, the term category was used in reference to the set that represents a concept (e.g., trees, bushes). Spradley (1979, p. 98) pointed out that by placing elements in a category we treat them as though they were equivalent.

Macnamara (1982) stated that meaning denotes "something that ordinary people have in their heads.... meaning must be attainable without a scientific training, and meaning must be the same for all who use a word to communicate" (p. 211). Macnamara asserted that a concept is defined by the "necessary and sufficient conditions for category membership." For concepts such as dog and tree, however, there are no necessary and sufficient conditions. Macnamara explained this problem by stating that those conditions exist but are as yet unknown to us. Despite his protestations to the contrary, Macnamara appears to cling to the positivist stance that a concept has an absolute essence.

Novak, Gowin, and Johansen (1983) have defined a concept as, "a perceived regularity in events or objects designated by an arbitrary label" (p. 625). They have stated the belief that "concepts do not have 'fixed' meanings.... Concept meanings are developed primarily in the extent that they are embedded in frameworks of propositions, and hence it is the set of propositions that a person has incorporating a given concept that defines that person's idiosyncratic meaning for the concept" (p. 626). Novak et al. assert that meaning depends on context and a concept can have multiple idiosyncratic meanings.

Rosch and Mervis (1975, p. 573) pointed out that in the past linguists and psychologists had assumed that linguistic categories have distinct boundaries and membership that is defined by a set of criteria possessed by all members. By this model a category (concept) is defined by a set of necessary and sufficient conditions that distinguish it from all other groups.

Research by Kempton (1981) and Rosch and Mervis (1975) indicates that meaning is not absolute, nor is it the same for all individuals. Kempton pointed out that a model for the meaning of a category based on necessary and sufficient conditions ignores the importance of many features. A tree cannot be defined simply by the presence of wood and a single tall trunk, as stated in dictionary definitions.

If meanings are idiosyncratic, then how can individuals communicate with each other? Kelly (1955) asserted that communication depends on the extent to which individuals can "construe the construct system" of others. Research by Rosch and Mervis (1975) and Kempton (1981) has supported a model of meaning based on the concept of a prototype. The prototype is the "clearest case, best example of the category" (Rosch & Mervis, 1975, p. 574). Category membership is determined by the degree of resemblance to a prototype. Rather than having distinct boundaries, the attributes of natural categories overlap, that is, some of the attributes of one category are shared by other categories. Of all members of the category, the prototypical members bear the largest number of attributes relevant to the category and have the least resemblance to members of contrasting categories.

Kempton (1981) stated that:

> Perhaps the most important difference between folk classification and devised classification is the use of grading. The elements of most folk categories are graded from prototypical examples in the center to atypical ones on the fuzzy boundary of the category (p.4).

It was the plant classification schemes of nine sixth grade children that was examined in the current study.

Research Design

The plant categories of nine children were examined through a series of tasks. The sixth grade children, four males and five females, lived in a small university town in central Texas. They came from a variety of economic and ethnic backgrounds (African-American, Anglo-American, and Mexican-American) and had achievement test scores ranging from low to very high.

Each child was interviewed separately. On the first interview, the child identified 64 species of plants from photographic slides. The names for plant categories that the child used in that interview (e.g., tree, bush, vine) formed the basis for the second interview, in which the child listed all the names for members of each category that she/he could think of. Next, the child identified plants on an outdoor field trip in the familiar setting of the child's own neighborhood. The names for categories of plants were elicited through questions such as, "What kind of thing is an oak?" (Child's response, "It's a tree.") Category membership was further explored through questions such as, "Point out all the trees around us," "Are these two trees the same kind of tree?" Criteria for category membership was examined through questions such as, "How can you tell a bush from a tree?" "How can you tell these two trees are different?"

Next the child was given a stack of photographs of 74 species of plants. The child was asked to sort the photographs into groups. Then the researcher asked the following questions for each group: "What name would you give this group?" "Explain what the members of this group have in common." "How is this group different from that group?" To examine the gradation of categories, the following questions were asked: "Of the trees, which are the most typical trees?" "Which are the least typical?" "Of the ones that are not trees, which are sort of like trees?" Finally, each child was taken on an outdoor field trip in an unfamiliar site (the same site for

all children) and again asked to name plants and provide information on category membership.

Category membership was analyzed using Spradley's (1979) techniques for domain, componential, and taxonomic analysis.

Results

Plant categories

The children in this study commonly used the following major plant categories: plants, trees, bushes, flowers, vines, grass, cactus, and weeds. Two individuals used leaves as a category. Other categories were used infrequently and were not analyzed: moss, mold, ferns, mushrooms, and berries.

Many of the children's categories (i.e., trees, bushes, flowers, vines, grass, cactus, and weeds) would be acceptable to an adult layman. With the exception of leaves, all the children's names for plant categories would be recognized by the adult layman.

The children's labels for all categories except flowers and leaves would be acceptable to a botanist as informal plant categories, although they would not be recognized as taxonomic groupings. The botanist would be more inclined to refer to shrubs rather than bushes. Two of the children's categories, cactus and grass, are labels for botanical families and, therefore, could be acceptable as taxonomic groupings. In no category, however, did all individuals select members that would be acceptable to a botanist. Thus, for no category could it be said that all individuals shared meanings with botanists. Several individuals (two to six in each category) had botanically acceptable members for the categories tree, bush, grass, vine, and cactus.

Only one child seemed to use plants consistently in a manner that would be acceptable to a botanist. For most children plants was polysemantic (had multiple meanings). Although most recognized that trees can be plants, three did not. The children rarely used plants in an all-encompassing manner. The category typically was used in reference to herbaceous, non-flowering plants or as a residual category, a dumping ground for otherwise unclassified specimens. Even for those individuals who knew that trees are supposed to be types of plants, there was a strong tendency to believe that trees are not "real plants."

At least seven children seemed to separate all plants into two broad categories. These divisions were either named (trees versus plants) or were implied. Woodiness, size, and color may have been the criteria used to differentiate these two divisions. Trees and bushes were the only categories with consistently brown-stemmed (woody) members (although some non-woody specimens were occasionally placed in these groups). Most members of plants, grass, weeds, leaves, and flowers were green-stemmed (herbaceous) and smaller than trees and bushes.

The following comments by the children exemplify their confusion on the differentiation between plants versus trees and bushes.

"Plants are mostly all green."

"A tree is not exactly a plant. On top, it's a plant. It's not an animal so it must be a plant. The leaves are the part that's a plant."

"A bush kind of has to be a plant. It seems half plant, half tree. Because of its branches."

In a study with six children, ages 3-8, in Berkeley, California, Dougherty (1979) found that the oldest children used the following plant categories: plants, trees, bushes, flowers, vines, grass, cactus, leaves, ferns, mushrooms. Dougherty also noted a polysemous use of the category plants. Her children tended to place plants into binary sets (trees versus plants). Brown (1984, p. 100) speculated that binary contrast (e.g., large versus small) is a common method of designating plant and animal categories in various languages. Botanists sometimes use an informal binary division of flowering plants, with the divisions labeled woody versus herbaceous.

In a summary of ethnobotanical studies conducted in a wide variety of cultures, Brown (1984) described the attributes of the major plant categories found in the most number of languages. He signified those categories by the following terms: tree (large woody plants), grerb (small nonwoody plants), bush (bushy plants of intermediate height), vine (plants with elongated stems that creep, twine, or climb), and grass (non-flowering herbs with narrow leaves). Brown found the English folk terms useful for signifying all but one category, grerb. English speakers in the United States do have a category for small nonwoody plants, but the label they use for that category is plants. To avoid confusion Brown chose to use the invented term, grerb, to signify that category. Grerb is a combination of the English terms grass and herb.

The plant categories used by the children in the current study are remarkably similar to those used by the children in Berkeley and by adults in various cultures worldwide. These categories, while not matching scientific taxonomic groupings, do match the categories used by laymen in various cultures.

Criteria for category membership

Most of the children's major plant categories relied on structural, non-subjective attributes as the main criteria for selection of members. Trees have trunks, bushes are shorter and rounded, grasses are small and green, cactus have spines, flowers have flowers, vines have long, flexible stems.

For trees, bushes, vines, and cactus the presence or absence of the criterial characteristics does not vary from season to season. Trees and bushes remain woody real round. Vines do not lose their long, slender stems as they get older. Cacti do not lose their spines. These categories were generally stable (membership would not change seasonally) and informants' selections were fairly predictable. Children's comments about these categories include the following.

"A bush is smaller (than a tree), more in a round shape with more leaves."

"Adults are usually taller than bushes. Trees are usually taller than adults."

"Bushes are short and fat and have a whole bunch of little tiny leaves."

"If it was a tree, you could definitely see the trunk."

"A tree is straight up, then it branches out. A bush starts spreading out before it gets tall."

Vines are "just real long and stretchy. And they're real hard to break."

Vines have "long stems you can bend."

Cactus "got thorns. They're green."

It's a cactus "because it's prickly."

One student had sub-categories for cactus that differentiated between different specimens. "There are many kinds of cactus. There are your poikey cactus (referring to a yucca) that don't really hurt you, they're just pokey. If you run into them, you won't die. They'll just make you go away. This (referring to a true cactus) will make you go away very quickly because they're sharp. These (referring to agave) are like the poikey ones, only they're on the ground more, and they have spikes. They're all related to cactus and they're all sharp."

For the various herbaceous categories, flowers, grass, plants, weeds, and leaves, the children's structural criteria were virtually identical. The criteria included overall greenness and low growth habit, smaller than trees or bushes. The following are examples of student comments about these categories.

"Plants are things with leaves close to the ground. The roots aren't as sturdy as a tree. They have soft vein roots, not wood roots."

"You know how trees are like a brownish color? Plants most time it's like a weird greenish color. So if I see a green stem, with some kind of weird shape on it, like a green leaf, that looks smooth or something, I mostly classify it as a plant."

"I think a plant and a flower is just about the same thing...They all have stems that look similar."

"Flowers have stems, flowers, green leaves, petals."

"They all (flowers) got a stem with a flower at the end of it."

"Grass is little short stuff."

"Grass is short, skinny, green."

"A weed you can pull up usually."

"Weeds are little things that you can step on. They can get big. They can get real big. But they're too flimsy."

"Weeds are all those little short plants that aren't super short near the ground."

Differentiation between the herbaceous groups frequently was dependent either on variable criteria, such as the presence or absence of flowers, or subjective criteria such as prettiness.

"Flowers are pretty and smell good."

"It doesn't look like a flower if it doesn't have the flower on it."

Grass was a predictable category only for those few children that relied on leaf shape as a criterion.

"Grass leaves are straight up and down, and weed leaves... are kind of curly and sort of like tree leaves."

For others, any small herbaceous plant in the lawn that was not in bloom might be called grass.

"Weeds, flowers, and herbs are all grass."

"Grass is usually small and doesn't grow that big. Cause usually you mow it. It doesn't grow as tall as weeds, sometimes."

Classification of weeds was based on subjective criteria as well as unstable structural criteria. For some children, any plant was a weed if it grew where it was not wanted. For others a flowering herbaceous plant was a flower if it was pretty and a weed if it was not.

"A weed is something that grows where you don't want it to grow."

"Weeds are ugly."

"They're plants, not weeds, because I know you have to plant them."

"Weeds can kill flowers."

The children were sometimes aware that certain specimens could be placed in more than one category.

"Clover is really like a weed because it grows by itself. Clover is also flowers."

"Flowers usually just grow on a plant (rather than a tree)."

The combination of variable and subjective criteria made the herbaceous categories unstable, resulting in extreme overlap in category membership. When an herbaceous plant had a flower, it usually was placed in the flowers. When the flowers were absent, the species might be called a plant, grass, weed, or leaf. Thus flowers was an unstable category although fairly predictable. The alternative herbaceous categories were usually unstable and unpredictable. Selection typically was based on the absence (rather than the presence) of the critical criterion, flowers, and an arbitrary choice between the four other categories, categories that sometimes served as residual categories, dumping grounds for otherwise unclassified specimens.

Despite the sometimes unstable criteria chosen by children, there was remarkable agreement between students on what criteria were important for each category. Most structural criteria used by the students, such as overall form, size, leaf type, trunk form, stem form, and herbaceous or woody habit (which for these children may have been indicated by color of stem), were criteria that botanists use in classifying plants.

Dougherty (1979) found that children as young as three years old used structural criteria for classification of plants. She also noted a tendency to use unstable criteria (e.g., presence of flowers, fruit, or leaves). She assumed the children would be less likely to use unstable criteria as they got older. The results of this study have indicated that such tendencies remain in older children.

Prototypes

This study provided evidence that the children used prototypes in plant classification. For trees, bushes, vines, flowers, plants, and weeds, the child's prototype was frequently readily apparent. The verbal statements made by the children evoked a mental image of a particular type of tree or bush, for example. The following are the inferred prototypes for each category and samples of the children's comments.

Based on verbal statements and member selections, the prototypical plant appeared to be small, green and herbaceous, lacking showy flowers.

"Plants are all green most of the time. They're real short. Most of the stems, they break easier (than a tree) if you bend them."

The prototypical tree was a broadleaf deciduous tree with a tall trunk (or trunks) and branches that spread out at some distance from the ground. The prototypical bush appeared to be a small, trimmed, rounded hedge with closely packed leaves that hide the trunks.

"A bush is a little squatty thing that sits on the ground with a bunch of leaves and everything and it's usually green. A tree is a big tall thing with a trunk with branches sticking out...Trees lose their leaves in the fall and a bush's leaves stay green."

"A bush comes straight from the ground. It doesn't have very much of a trunk. And there's leaves going all over. There's not distinct little branches on a bush."

"A tree is like a bush on a trunk."

The prototypical grass was mowed turf grass, a low-growing herb with no obvious flowers and narrow leaves.

"Grass grows straight up. Grass doesn't have a stem."

Most children, however, included several non-grasses in the category. One child called basically any small green herb growing in the lawn grass. Another child stated that "weeds, flowers, and herbs are all grass."

The prototypical flower was small and herbaceous with showy flowers.

"A flower grows straight out of the ground and forms into a bloom."

Despite differences in verbal criteria for the category, for most children the prototypical weed was wild, non-flowering, and herbaceous. For several children, grass in seed was the prototype. Looking at a photograph of Johnson grass in seed, one child said, "It's just a classic

example of weeds." For only one child was a woody plant, the hackberry tree, the prototype.

The prototypical vine appeared to be a climbing, herbaceous or green stemmed plant with long, slender, flexible stems. The specimens selected as vines were generally non-woody although some children included a few woody specimens as well.

"A vine is really long, and it just lays on the ground, and it crawls up the wall." "It cannot grow without having something to support it."

Despite the fact that many selections were not true cactus (e.g., yuccas and agaves), the prototypical cactus appeared to be a true cactus, with spines and a green stem. Members of the category cactus were often as large as trees and bushes, and members sometimes overlapped into other categories, such as trees, bushes, and flowers.

"Cactus is green, lots of little thorns on them."

"Cactuses are real ugly, and then all of a sudden they have flowers on them."

Polythetic and monothetic categories

A polythetic category is distinguished by (rather than defined by) multiple features. Trees was a polythetic category for all nine children. For five children trees may have been the only polythetic category. For three or more children bushes may have been polythetic. For at least two children grass and cactus seemed to be polythetic categories. These two children included only true grasses and true cacti (with one exception, one yucca) in their selections. They were the only students for whom category membership resembled botanically accurate categories for the scientific taxonomic groups grasses and cacti.

The polythetic categories had well-defined prototypes and fairly predictable category members. Polythetic categories frequently include specimens that share some but not all the criteria of the prototype. In contrast, a monothetic category depends on only one or a few critical (necessary and sufficient) criteria to define membership. Grass, flower, vine, cactus, and weed were monothetic categories for most of the children. To qualify as a grass, the specimen must be green and small. To qualify as a flower, the specimen must bear a flower. To be classified as a vine, the specimen must have elongated, slender, flexible stems. A cactus must have

spines or prickles. The criteria used for classifying weeds differed with the children - either it was ugly, or it was wild, or it was growing where it was not wanted.

In a polythetic category what criteria are shared with the prototype varies, whereas with monothetic categories the shared criteria is always the same. Thus, there is no apparent gradation of characteristics in a monothetic category. Membership is on an all-or-nothing basis. Even when the category was monothetic, however, the children's selections and statements provided evidence that the children usually had a prototype in mind. For example, although presence of flowers was the critical criterion for membership in flowers the statements and selections both pointed to an herbaceous prototype.

In this study, generally only specimens that shared all the critical criteria were included in the monothetic categories. A specimen that was classified as a flower during it's blooming period would typically not be classified as flower after the bloom was gone. The common tendency to use several of the monothetic categories as residual categories, however, resulted in some unpredictable selections. For example, while most specimens selected as weeds were herbaceous, indicating a tendency to rely on an herbaceous prototype, a few woody plants might be included also.

The polythetic categories had more consistent and predictable members than did the monothetic categories. With the polythetic categories, a variety of sources of evidence pointed to the importance of prototypes. Typically no criterion was shared by all members, but each member shared one to several criteria with the prototype. Specimens were selected by virtue of sharing any one or more of a family of characteristics. Few specimens shared all of the criterial attributes of the prototype. No single criterion was necessary and sufficient to category membership. For example, although tree selections were predictable the informants' verbal statements (exemplifying the prototype) did not match the wide range of plants the individual actually chose for the category. Among the specimens designated as trees, not all had woody trunks and not all had an obvious crown.

In the informants' polythetic categories, membership was based on degree of resemblance to the prototype. Specimens sharing several or all criteria of the prototype tended to be designated as "most like" the category (e.g., oak trees). Specimens sharing only one or few criteria with the prototype tended to be designated as "least like" the category (e.g.,

agaves). A gradation of shared criteria was apparent. Thus the category included prototypes with extension. Selected members either matched the prototype or had gradually fewer attributes of the prototype, i.e., they extended out from the prototype.

For example, the children frequently included a photograph of a Joshua tree, a type of yucca, among the specimens that were "least like a tree." Though clearly unlike the prototype, the Joshua tree was included in the category because, as stated by one student, "it looks like it has bark, and it has spreading (trunks)." "It has the trunk of a tree, but it's all curved." Another yucca is "least like a tree because they look shorter and they are growing these (flower stalks) up here." Yucca, "the way it's not like a tree, it doesn't really have any leaves, and it doesn't really have bark. It's just not the same."

The cholla, a branching cactus, is "least like a tree because inside, they would be green and because they have thorns everywhere." Agave is a "tree without many branches or leaves."

With increasing distance from the attributes of the prototype, specimens shared more attributes with other categories. Specimens on the fringes of the category were often classified in more than one category. For example, a small tree with more than one trunk might sometimes be called a bush. A bush with long, flexible branches may sometimes be called a vine.

With the categories tree and bush, the atypical members were at the fringes of the categories with an obvious overlap between categories and a gradation of shared characteristics from one category to the other. For example, junipers were variously classified as trees or bushes. The smaller specimens often had the trunks hidden by the leaves, thus more closely resembling the prototypical bush, while the taller specimens with exposed trunks more closely resembled the prototypical tree. One child commented about a juniper, "It's a tree. It's real short to the ground like a bush. Like a tree, all the branches extend way out."

Conclusions and relevance to Kempton's prototype model

Although the students did not use scientific plant categories such as monocot and dicot, all their major plant categories, with the exception of the category leaves, would be recognized by the adult layman and generally used in a similar manner. Two categories, grass and cactus, are

labels for botanical taxonomic groups, but only two children had botanically acceptable category selections.

The children's categories clearly were examples of folk categories rather than devised scientific categories. Some of these folk categories (flowers, leaves) would not be acceptable categories from the point of view of the botanist. But botanists do use some folk categories (e.g., tree, vine, bush/shrub) in describing plants. Although category membership differed idiosyncratically, the basic defining attributes of categories and the prototypes tended to be similar from child to child. This indicates that the categories have socially constructed shared meanings while maintaining idiosyncratic category membership.

In a study of the names and classifications for ceramic pottery in Mexico, Kempton (1981) had individuals name and define the attributes they used to distinguish between various pottery mugs and jars. He noticed that the verbal folk definitions and dictionary definitions for the pottery terms he was studying "both oversimplify by omitting crucial information, especially the important component of vessel shape" (p. 36). Kempton found that the definitions did not provide enough information to allow someone unfamiliar with the language to use the term correctly. Verbal folk definitions and dictionary definitions both assumed a shared cultural background between the speaker and the listener.

To overcome this difficulty, Kempton had the individuals explain their classifications. By pointing out apparent discrepancies in category selection and having the individual justify the selection, Kempton was able to discover the importance of the height-to-width ratio (shape) in category selection.

Kempton asked the individual to designate which drawings of pots were the best examples of each type of pot, ollas, for example. He also asked the individuals to designate which drawings were "sort of" ollas. Thus, four grades of membership were examined, simple membership (all objects that are examples of ollas), focal membership (the best examples of ollas), peripheral membership (sort of an olla), and nonmembership (everything else).

Kempton found classification differences between older and younger individuals, men and women, potters and nonpotters, and differences between individuals from traditional and more modern villages. He found that the groups differed widely in their simple members but tended to have the same prototypes (focal members). Thus differences between

groups appeared in the rules of extension. For example, the experts - potters and women - allowed more variation in shape and less in attachments than did nonexperts. He also found that the features important to category membership (neck position, width-to-height ratio, and attachments) tended not to differ between groups. Features simply varied in how they were weighted between groups. In other words, variation could occur in the features, thus category membership could change, but the same features were used to select the members.

Kempton found that "categories are structured as a prototype symmetrically surrounded on all sides by successively lower grades of membership" (p. 167). He noted that features were additive. "The features of shape and attachments interact with each other, each adding to category membership" (p. 57). Rather than making category selections feature by feature, category membership was based on "distances from a prototype" (p. 99).

Although the prototype was central to category membership, individual features, the components of meaning, affected meaning. If a feature deviated too much from the prototype, the object no longer belonged in the category. Kempton pointed out that not all important features were graded. Some features, such as presence or absence of a spout, were discrete. Nonetheless, the total number of features present in a series of specimens was graded, whether or not individual features were graded or discrete.

In attempting to define a category, if one described the prototype only (as sometimes occurs with dictionary definitions), the definition would be too restrictive as it would exclude everything that did not share all features of the prototype. If one described only the features important to category membership, the definition would again be too restrictive, as such a definition would ignore the additive and interactive aspect of the features.

Kempton suggested that in defining category membership, one should "describe the prototype... [and then give] the culture's rules for judging similarity to the prototype" (p. 103). "A prototype-based definition includes additional features possessed by the prototype but not by other members of the category. It therefore defines the entire category as "the prototype and things similar to it" (p. 197). Thus category membership is defined by the prototype with extension.

Macnamara (1982) said that in order for communication to be possible meanings must be the same. Kempton (1981) found that individuals were able to communicate meaningfully with each other about ollas and other categories of pots even though they selected different referents. The objects designated as ollas varied considerably between individuals but the objects designated as prototypes varied less. As long as their prototypes were similar the individuals shared enough components of meaning to be able to carry on meaningful conversation about ollas. Thus prototype theory provides an explanation of how communication is possible despite idiosyncratic differences in meaning.

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